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Competition between For-Profit and Industry Labels

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Competition between for-profit and industry labels

The case of social labels in the coffee market*

Pio Baake[†] Helene Naegele[‡]

September 19, 2017

Abstract

We model strategic interaction on a market where two labeling organizations compete and firms in duopoly decide which labels to offer. The incumbent label maximizes its own profit, and is challenged by an industry standard which maximizes industry profit. Using a nested logit, the result of this multi-stage game depends crucially on the degree of horizontal differentiation. Joint firm profit always increases with the introduction of the industry standard. The industry standard wants to segment the market and strategically distorts its label quality downwards, such that each firm specializes in a different label. Social welfare however increases with the number of labeled products. A policy imposing a minimum label quality is only binding in the case of strategic quality distortion by the industry standard.

JEL classification: L15, D43, L13
Keywords: product differentiation, certification, nested logit

1 Introduction

Over the past decades, consumers have become more and more interested in the social and environmental impact of their consumption. However, most sustainability aspects of a product are difficult for consumers to verify, even after purchase, meaning that the promise of a responsible production process is essentially a *credence attribute* that cannot be verified either before or after purchase. Firms increasingly use voluntary third-party labels to solve their credibility problem.

The coffee market has a particularly large number of well-established sustainability labels; the most important being Fairtrade, Rainforest Alliance, and UTZ Certified. These target

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the well-being of farmers and the environmental impact of production. The stringency of the labels varies: Fairtrade, for example, guarantees a price premium for farmers, while the price premia established by UTZ Certified and Rainforest Alliance are lower and not guaranteed.[1] When it comes to social sustainability labels, higher farmgate prices are seen by consumers as higher quality and justify higher prices.

When each firm can offer several differentiated products, various constellations of product lines can arise. In the coffee example, an international comparison illustrates this multitude of possible product line constellations: in Germany, most roasters[2] offer a range of products including conventional, i.e. not labeled, and labeled coffee of several labels (head-to-head competition). In other countries, such as Finland,[3] coffee roasters have specialized so that each label is only offered by one roaster (market segmentation).

This paper establishes a model of label competition, between a for-profit label and an industry standard. To start with, we model the firms' choice of a third-party label offered by a for-profit licenser in the first period. We are interested in the interaction between the licenser, which sets a license fee and a label quality, and firms, which decide on their product line and their prices. Each firm can offer several goods that are differentiated both horizontally between firms and vertically through quality. In a second period, we allow firms to establish its own labeling organization – an industry standard – that maximizes joint firm profit. We then analyze how the industry standard sets its quality and what product lines are offered in equilibrium.

In both periods, we find that equilibrium product lines depend crucially on the degree of (exogenous) horizontal differentiation: the market is segmented if horizontal differentiation is weak, i.e. each label is offered by one firm only. In contrast, firms are in head-to-head competition when horizontal differentiation is strong, that is both firms offer all available labels. When there are two labels and horizontal differentiation is intermediate, the industry standard strategically distorts its quality downwards in order to induce a segmented product line.

Overall, we illustrate why an industry facing a third-party label has an interest in establishing its own industry standard: the presence of a second label reduces the fees set by the

[1]Fairtrade Labeling Organizations International (FLO) guarantee a price premium at the farmgate of \$0.20/lb (since 2011) over the stock market price. UTZ Certified in 2012 reported sales prices that result in an average premium of \$0.04/lb over the price index of the International Coffee Organization; the prices for Rainforest Alliance are not known but they reported a premium of \$0.11/lb in 2009 (Potts et al., 2014). In 2012, Fairtrade and Rainforest Alliance had similar market shares of 2-3% worldwide while UTZ had almost twice as much, with much larger market shares in countries like the United States, Germany, and Great Britain.

[2]The German coffee market is dominated by JDE/Mondelez, Aldi, Tchibo, Melitta and Dallmayr; together they hold 90% of the market (Villas-Boas, 2007, adjusted for the merger of JDE/Mondelez in 2015).

[3]In Finland, per capita coffee consumption is the highest in the world. The average Finn consumes 9-10 kg of roasted coffee annually; approximately four cups per day (Valkila et al., 2010). There are just two major companies on the Finnish coffee market: Meira and Paulig.

for-profit licenser, and an additional vertically differentiated good increases product lines, thereby increasing overall demand. Moreover, for intermediate levels of horizontal differentiation, the industry standard strategically reduces competition by reducing product line overlap, thereby increasing mark-ups.

We further ask whether regulation in form of a minimum quality requirement for labels, such as established in organic farming, can increase welfare. In the first period with one label, a minimum quality requirement increases the label's standard, thereby increasing welfare. Welfare increases if firms are in head-to-head competition, but the minimum quality requirement cannot affect the equilibrium product line. In the second period with two labels, the social planner can set its minimum quality requirement such that it prevents the industry standard's strategic downward distortion, thereby maximizing the number of labeled products. Whenever the industry standard does not strategically distort its quality downwards, the social planner aims at setting *lower* qualities than the industry standard. In these cases, a minimum quality requirement does not bind and does not impact welfare: the duopoly firms in equilibrium differentiate *too much* from conventional market and too little from the higher label.

In the remainder of this paper, we begin by discussing the relevant literature and explain the context of the coffee market and fairtrade research. We then explain the model and each player's objectives in Section 2. We first solve the first period with only the for-profit licenser in Section 3. Then, we solve the model in the second period upon entry of an industry standard in Section 4. For each period, we explore whether there is scope for a government-imposed minimum quality requirement. Finally, we conclude in Section 5.

1.1 Related literature

Our model features both vertical differentiation between labels and horizontal differentiation between firms. Methodologically, this study relies on a large literature using the nested logit model established by McFadden (1978). In particular, the version of Anderson and De Palma (1992) with multi-product firms allows us to explicitly model the endogenous substitution elasticity between labels depending on label differentiation. Gallego and Wang (2014) use such a nested logit to account for horizontal and vertical differentiation. Von Schlippenbach and Teichmann (2012) and Yu and Bouamra-Mechemache (2016) model how standards are used by different agents (retailers, resp. manufacturers) to strengthen their bargaining power within the vertical supply chain. The choice of firms in duopoly adopting a labeled product line also relates to product line rivalry (e.g. Avenel and Caprice, 2006). Cheng and Peng (2012) show the importance of strategic effects in quality setting when a firm can offer more than one vertically differentiated product.

A growing literature is studying voluntary third-party certification, for a review see Bonroy and Constantatos (2015). In particular, newer papers study the interaction between several labeling organizations and firms, focusing on endogenous quality levels. Fischer and Lyon (2014) model the rivalry between an ecolabel set by an NGO and an industry-standard in the forestry sector and find that the industry-standard lowers environmental benefits even if consumers are perfectly informed. Poret (2016) models the competition between two NGOs setting labels with different objectives. Similarly to this study, Bottega et al. (2009) study the interaction between a regulator, an industry standard and a for-profit licenser. However, all these studies consider simple market constellations (monopolist/single-good duopoly), following in particular the model by Heyes and Maxwell (2004). Finally, a strand of literature explores the effect of consumer confusion when several labels coexist or monitoring is imperfect (Harbaugh et al., 2011; Mahenc, 2010; Mason, 2011), whereas we assume that consumers observe label quality perfectly.

1.2 Coffee market and fairtrade

In our model, the incumbent labeling organization maximizes its profit. Previous theoretical research on fairtrade has modeled an NGO label maximizing farmer welfare (Podhorsky, 2015; Richardson and Stähler, 2014; Chambolle and Poret, 2013). However, it is difficult to argue that the FLO price policy is aimed at maximizing farmer welfare. A concise theoretical model by Janvry et al. (2015) shows how farmer rents are eroded by unlimited entry of farmers, such that in equilibrium all the price premium goes to the licenser in form of the farmer annual fee. Crucially, fairtrade guarantees prices, but not sales, such that fairtrade-labeled farmers typically sell large proportions of their production as conventional coffee, i.e. without the label at world-market prices (e.g. Valkila and Nygren, 2009; Panhuysen and Pierrot, 2014).[4] Moreover, annual license fees are high for both roasting companies and, in particular, for farmers, which contrasts with the idea that an NGO maximizes label participation.[5]

This paper concentrates on the impact of labels in the consumer country, excluding the farmer from the picture: we interpret fairtrade as a quality label. Fairtrade coffee is an amply available commodity and farmers have no market power. Johannessen and Wilhite (2010) estimate that about 75% of value added in fairtrade coffee remain in the consumer country. Empirical evidence suggests that farmers receive a higher price for fairtrade coffee than for conventional coffee (Beuchelt and Zeller, 2011; Dragusanu and Nunn, 2014; Arnould et al., 2009), but the impact on income is small at best when controlling for

[4] Panhuysen and Pierrot (2014) show that about a quarter of certified coffee production is sold with a label.

[5] Under standard assumptions, an NGO label maximizes access to its label and sets its fee as low as possible, that is equal to the cost of monitoring (cf. Bottega and De Freitas, 2009), which is normalized to zero in our model. If the cost of the label is zero, then our model predicts that it is always an equilibrium for both firms to offer the label. Only in markets with very weak horizontal differentiation, market segmentation might be an additional equilibrium. However, this does not reflect the reality of coffee markets.

selection into the labeling scheme (Ruben and Fort, 2012; Saenz Segura and Zuniga-Arias, 2008; Beuchelt and Zeller, 2011). Dragusanu et al. (2014) review this literature in more detail.

Nevertheless, marketing and experimental research has consistently shown that consumers have a positive willingness-to-pay for fairtrade products (e.g. Basu and Hicks, 2008; Pelsmacker et al., 2005; Loureiro and Lotade, 2005). A rational consumer understands that it is welfare-enhancing for a farmer to sell more fairtrade coffee, once he has incurred the fixed entry costs of labeling. Moreover, Friedrichsen and Engelmann (2017) and Teyssier et al. (2014) show that social image concerns play a role, so that consumers enjoy being seen buying fairtrade products. Another possible explanation of the wide-spread support of the fairtrade system is that consumers are not aware of the dynamic effects of the fairtrade system leading to an excessively large number of certified farmers. We assume that consumers derive a homogeneous positive utility from higher coffee prices at the farmer level, leaving aside the debate whether these preferences are due to social image, *warm glow* (Andreoni, 1989), or pure altruism.

2 Model

We analyze a game with two periods, each consisting of several stages. The game involves two labeling organizations $s = F, I$, two horizontally differentiated firms $i = 1, 2$, and homogeneous consumers which value quality positively. Firms can offer several vertically differentiated products: they always supply a product of conventional market quality q^C and can additionally opt for one or both labels. We assume that firms cannot credibly offer qualities higher than conventional market quality $q^C = 0$ without getting labeled by a labeling organization.[6] The labeling organizations decide on qualities q^F and q^I, guaranteed by their respective label. The for-profit licenser moreover sets a license fee L. Subsection 2.4 provides a detailed overview of the game sequence.

2.1 Consumer demand

To capture both horizontal and vertical product differentiation, we specify consumer demand using a nested logit model (cf. McFadden, 1978; Anderson and De Palma, 1992). In our model, products become closer substitutes when their qualities become more similar. This section derives the demand equations in the case where both firms offer both labels. The firms' market shares and demand functions for other product line constellations can be derived analogously.

[6]The certification and labeling process is assumed to be credible and to guarantee that labeled products fulfill the quality requirements defined by the licensers. We further assume that consumers are perfectly informed about the qualities chosen by the licensers.

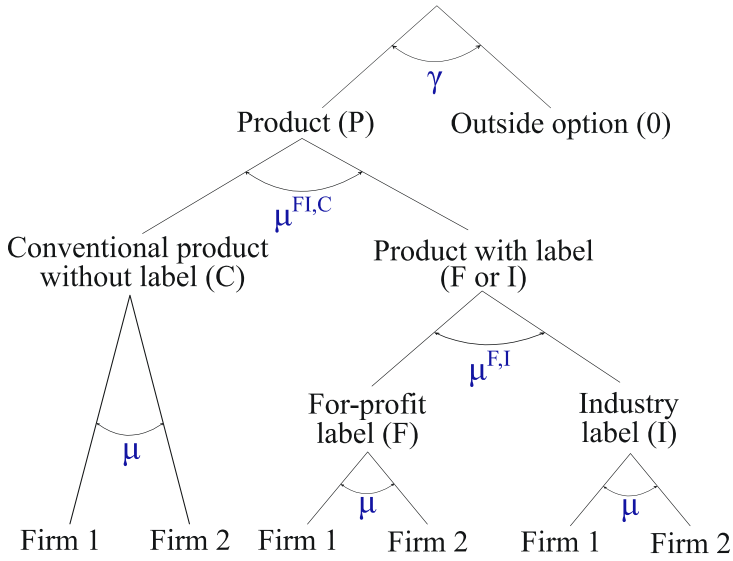

Figure 1: Nested decision-making structure of consumers

Assume that each firm offers three products with qualities q^F, q^I, and q^C, then Figure 1 shows the decision structure of consumers. Each of the homogeneous consumers buys one unit or opts for the outside good. Consumers decide *if* they want to buy any product (decision between nest P, for product, and nest 0, for outside option). If consumers choose nest P, they decide between products with and without labels (decision between nests FI and C). Within nest FI consumers choose between labels (between nests F and I). Finally, within each nest s with $s = F, I, C$ consumers decide from which firm they buy. Figure 1 illustrates this decision structure, where the substitution parameters $\mu^{FI,C}, \mu^{F,I}$ and μ are explained below.

Proceeding backwards, consider first consumers' decision within nest s ($s = F, I, C$) between both firms' goods. Each consumer chooses the firm i that maximizes his indirect utility

$$u_i^s = \bar{u} + v(q^s) - p_i^s + \mu\epsilon_i^s, \tag{1}$$

where $\bar{u}$ is the consumer's direct utility of the product, $v(q^s)$ denotes the additional utility from consuming quality q^s and p_i^s the price of firm i's product with quality q^s. ϵ_i^s is an error term that is distributed with the extreme value distribution. In the example of fairtrade coffee, quality is defined by the farmgate prices guaranteed by the labeling organization. The parameter $\mu > 0$ measures the degree of horizontal differentiation between the two firms such that μ approaching zero translates into perfect competition within the final market. Consumers have a homogeneous valuation of quality $\nu(q^s)$ which is strictly increasing and strictly concave in q^s:

$$v^s = v(q^s) = \sqrt{\frac{q^s}{1 + q^s}}. \tag{2}$$

Integrating equation (1) over the distribution of the stochastic term ϵ_i^s, as it is standard in nested logit models,[7] we obtain firm i's within-nest market shares $\mathbb{P}_{i|s}$ for nest s

$$\mathbb{P}_{i|s} = \frac{\exp\left((\bar{u} + v^s - p_i^s)/\mu\right)}{\exp\left((\bar{u} + v^s - p_i^s)/\,\mu\right) + \exp\left((\bar{u} + v^s - p_j^s)\Big/\,\mu\right)} = \frac{\exp\left((\bar{u} + v^s - p_i^s)/\mu\right)}{\exp(A^s/\mu)} \tag{3}$$

$$\text{with } A^s = \mu \ln\left[\exp\left((\bar{u} + v^s - p_i^s)/\,\mu\right) + \exp\left((\bar{u} + v^s - p_j^s)/\,\mu\right)\right] \tag{4}$$

A^s measures the expected utility of nest s (given previous choices at higher nest levels), which is called the inclusive value in nested logit models.

Consider next the choice between F-labeled goods and I-labeled goods. The utility u^s of the nest s for $s = F, I$ is then defined as

$$u^s = A^s + \mu^{F,I}\epsilon^s \text{ for } s = F, I \tag{5}$$

where ϵ^s is a nest-specific error term that is distributed extreme value and substitution between nests F and I is given by

$$\mu^{F,I} = \mu + \frac{v^F - v^I}{1 + v^F - v^I}. \tag{6}$$

The specification of $\mu^{F,I}$ implies that $\mu^{F,I}$ approaches μ if the labels become more similar, i.e. if q^F approaches q^I. As before, integrating over the stochastic term's distribution, we obtain the market shares for nest F (and analogously for nest I):

$$\mathbb{P}_{F|FI} = \frac{\exp(A^F/\mu^{F,I})}{\exp(A^I/\mu^{F,I}) + \exp(A_F/\mu^{F,I})} = \frac{\exp(A^F/\mu^{F,I})}{\exp(A^{FI}/\mu^{F,I})} \tag{7}$$

$$\text{with } A^{FI} = \mu^{F,I} \ln\left[\exp(A^I/\mu^{F,I}) + \exp(A^F/\mu^{F,I})\right]. \tag{8}$$

Moving upwards, consider now the choice between choosing a labeled product or choosing conventional quality. The utility of the nest FI and of the nest C are defined as

$$u^{FI} = A^{FI} + \mu^{FI,C}\epsilon^{FI} \text{ and } u^C = A^C + \mu^{FI,C}\epsilon^C \tag{9}$$

where $\epsilon^{FI}, \epsilon^C$ is a nest-specific error term distributed with the extreme value distribution and $\mu^{FI,C}$ characterizes the substitution between FI and C. In analogy to equation (6) we use the following functional form

$$\mu^{FI,C} = \mu + \frac{v^F + v^I\left(v^F - v^I\right)}{1 + v^F + v^I\left(v^F - v^I\right)} \tag{10}$$

[7]See econometrics textbooks, e.g. Train (2009), for more details on the derivation of market shares in the standard nested logit.

Integrating gives the market share of the conventional products, given the consumer buys any product (nest P)

$$\mathbb{P}_{C|P} = \frac{\exp(A^C/\mu^{FI,C})}{\exp(A^C/\mu^{FI,C}) + \exp(A^{FI}/\mu^{FI,C})} = \frac{\exp(A^C/\mu^{FI,C})}{\exp(A^P/\mu^{FI,C})} \tag{11}$$

$$\text{with } A^P = \mu^{FI,C} \ln\left[\exp(A^C/\mu^{FI,C}) + \exp(A^{FI}/\mu^{FI,C})\right]. \tag{12}$$

Finally, consider the choice between buying any of the considered goods or the outside good, i.e. a substitute from another product category or nothing. Again, the utility of the nest P is defined as

$$u^P = A^P + \gamma\epsilon^P \tag{13}$$

where ϵ^P is a nest-specific error term distributed with the extreme value distribution and the substitution between the firms' products and an outside good is defined as

$$\gamma = 1 + \mu. \tag{14}$$

Normalizing the outside good's utility to zero, we obtain the probability to buy any product, i.e. the aggregated market share of both firms $\mathbb{P}_P$:

$$\mathbb{P}_P = \frac{\exp(A^P/\gamma)}{\exp(A^P/\gamma) + 1} \tag{15}$$

$$\text{with } A = \gamma \ln\left[\exp(A^P/\gamma) + 1\right]. \tag{16}$$

Note that the definitions of the substitution parameters ensure that we always have $0 \leq \mu \leq \mu^{F,I} \leq \mu^{FI,C} \leq \gamma$ such that goods within a nest are equally or more similar than goods from different nests.[8] Furthermore, consumers' preferences exhibit love of variety as the inclusive values in all nests increase in the number of products offered.

Summarizing and normalizing the total mass of consumers to 1, demand for firm i's products can be written as

$$D_i^F = \mathbb{P}_P \mathbb{P}_{FI|P} \mathbb{P}_{F|FI} \mathbb{P}_{i|F}, \tag{17}$$

$$D_i^I = \mathbb{P}_P \mathbb{P}_{FI|P} \mathbb{P}_{I|FI} \mathbb{P}_{i|I}, \tag{18}$$

$$D_i^C = \mathbb{P}_P \mathbb{P}_{C|P} \mathbb{P}_{i|C} \tag{19}$$

[8] We adopt the notation from Anderson and De Palma (1992), with substitution parameters at each nest level, which is formally equivalent to the notation more common in econometrics (e.g. Train, 2009), where the highest parameter γ is normalized to 1 and substitution parameters σ_k of lower nest levels are defined as $\mu^{FI,C}/\gamma$ and $\mu^{F,I}/\mu^{FI,C}$ and $\mu^s/\mu^{F,I}$. Therefore, our restriction on parameters ($0 \leq \mu \leq \mu^{F,I} \leq \mu^{FI,C} \leq \gamma$) is equivalent to the restriction $\sigma_k \in (0,1)$ in econometric work.

2.2 Firms

Firms decide, first, which label to acquire and, second, how to set product prices. Conventional quality q^C can be offered without any certification. Hence, we assume without loss of generality that firms always offer q^C and choose the profit maximizing price for this quality.[9]

We assume that marginal production costs $c(q^s)$ are equal for both firms, as well as constant and linearly increasing in q^s:

$$c(q^s) = q^s. \tag{20}$$

We define mark-up as difference of price p_i^s and marginal cost q^s. Firm profits are then sum of the demand D_i^s multiplied by the mark-up for each of its products, minus a license fee L if the firm offers label F. As an example, if both firms offer F, I and C, the firm i's profits are given by $\overline{\Pi}_{i:FIC|FIC}$:

$$\overline{\Pi}_{i:FIC|FIC} = D_i^F(p_i^F - q^F) + D_i^I(p_i^I - q^I) + D_i^C p_i^C - L \tag{21}$$

$$= \Pi_{i:FIC|FIC} - L, \tag{22}$$

where for readability, $\Pi_{i:FIC|FIC}$ is the firm's gross profit before payment of the fee to the licenser.

2.3 Labeling organizations

Both labeling organizations do not face any costs. The first labeling organization is licenser F that maximizes its profit. The licenser's profit Γ is given by the number of firms offering an F-labeled good multiplied by its license fee L. The second labeling organization is an industry standard I that maximizes joint profit of both firms; it does not charge any fees and has no own profit.

Both labeling organizations strategically set the quality of their respective label q^I and q^F. We assume that qualities chosen by the labeling organizations as well as the license fee are public information, without any room for private negotiation.

Licenser F is the established label and is challenged by the industry standard I. In the first period, we model the situation with only for-profit licenser F. The second period is modeled as a Stackelberg game: industry standard I enters and sets q^I taking into account the strategic adjustment of the licenser F's quality q^F and license fee L.

[9] Stated differently, a firm's decision not to offer quality q^C is equivalent to charging an infinitely high price for this quality, which is never optimal for a firm.

2.4 Game sequence

We analyze a game with two periods. In the first period $t = 0$, there is only one label, offered by the for-profit licenser. Licenser and firms play the following four stage game with perfect information:

Stage 0.1: Licenser F sets its license fee L_0 and its quality q_0^F;

Stage 0.2: Firms $i = 1, 2$ choose which label to offer, i.e. decide on their product line;

Stage 0.3: Firms set the consumer prices p_i^s for $s = F, C$;

Stage 0.4: Consumers choose their favorite product and buy 1 unit or opt for the outside good.

In the next period $t = 1$, the industry standard I enters the market, so that there is an additional stage 0, followed again by the previous four stages:

Stage 1.0: Industry standard I sets quality q^I;

Stage 1.1: Licenser F sets license fee L_1 and its quality q_1^F; the licenser cannot undercut his previous quality: $q_1^F > q_0^F$;

Stage 1.2: Firms $i = 1, 2$ choose which label(s) to offer, i.e. decide on their product line;

Stage 1.3: Firms set the consumer prices p_i^s for $s = F, I, C$;

Stage 1.4: Consumers choose their favorite product and buy 1 unit or opt for the outside good.

Note that we assume that the incumbent for-profit licenser in $t = 1$ cannot decrease its quality q_1^F below its equilibrium monopoly value q_0^{F*} from $t = 0$, without seriously harming its brand image. For simplicity, we further assume that the licenser in the first period does not anticipate the entry of the industry standard in the second period. In the following, we solve the game by backward induction.

3 Market equilibrium with licenser F only

We first look at the first period $t = 0$ before entry of the industry standard, i.e. with only a for-profit licenser F. The game starts with licenser F setting its quality q_0^F and fee L_0. Both firms can decide to offer an F-labeled product, there are thus three possible market constellations: both firms offer F or one firm offers F or no firm offers F. Since conventional quality $q^C = 0$ can be offered without any certification, we can restrict the analysis to the cases where the product line offered by each firm comprises at least C. Additionally, there can be no equilibrium in which licenser F sells no license; as consumers value quality and variety positively and licensers have no cost, choosing some $q^F > q^C$ and an arbitrarily small but positive license fee L, licenser F can always earn a positive profit.

3.1 Consumer prices

We first compute product price equilibria in stage 0.3 for all product lines and label qualities. Let $y, z \in \{FC, C\}$, we use the notation $\Pi_{i:y|z}$ for a firm i's profit when it plays y and the other firm plays z. Maximizing firm profit[10] $\Pi_{y|z}$ with respect to prices, we find:

Lemma 1 *For all possible product line constellations, there are unique equilibrium prices p_i^s with $s = F, C$ and $i = 1, 2$ in stage 0.3; moreover*

(i) when the product lines are symmetric (both firms offer the same qualities), prices are symmetric;

(ii) when firms compete head-to-head $\{FC, FC\}$ (both firms offer all qualities), the symmetric prices are given by the marginal production costs $c(q^s)$ plus a constant mark-up.[11]

Proof. See Appendix A on page 30. ■

We let $\Pi^*_{y|z}$ denote a firm's reduced profit when it plays y and the other firm plays z, given optimal price setting by both firms.

3.2 Product line decisions

Turning to stage 0.2 of the game and analyzing the firms' product line decisions, we compute the firms' best responses in choosing whether to offer an F-labeled good. Assume firm 1 offers F and C, then firm 2's best response is given by

$$\max\{\Pi^*_{FC|FC} - L_0, \Pi^*_{C|FC}\} \tag{23}$$

Solving the respective maximization problem if firm 1 does not offer F and using symmetry allows us to numerically compute the equilibrium in stage 0.2 of the game.

[10] We omit the firm index i if no confusion is possible.

[11] Considering a different nest structure Anderson and De Palma (1992) also obtain that equal mark-ups are optimal.

Figure 2 illustrates product line equilibria for different values of license fee L_0 and horizontal differentiation μ.[12] The lower the horizontal product differentiation μ, the less profitable it is for both firms to offer the labeled good simultaneously ($\{FC, FC\}$), as fiercer competition reduces their mark-ups. If the license fee L_0 is too high, neither of the firms offers the labeled good ($\{C, C\}$).

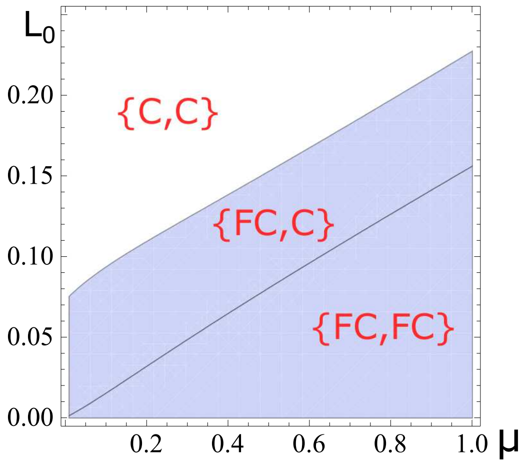

Figure 2: Product line equilibrium in stage 0.2 as a function of license fee L_0 and horizontal differentiation μ (for $q_0^F = 0.23$)

3.3 License fee

When deciding on its license fee L_0, the licenser F has two options: it can aim at selling licenses for its label to both firms or it can decide to sell just one license. Selling to both firms requires a low license fee, whereas selling to only one firm allows for a higher license fee. Maximizing its profits, the licenser sets the fee such that firms are just indifferent, i.e. at the edge of an area in Figure 2, either from $\{FC, FC\}$ to $\{FC, C\}$, or from $\{FC, C\}$ to $\{C, C\}$.

Assume that the licenser aims at selling its label license to both firms, inducing symmetric, head-to-head competition. The licenser then sets its fee such that both firms prefer offering FC rather than offering C; the fee equals the deviation profit given the other firm also offers FC:

$$L_0^{sym} = \Pi^*_{FC|FC} - \Pi^*_{C|FC} \tag{24}$$

We verify numerically, that this license fee L_0^{sym} indeed ensures that both firms want to offer label F:

$$\Pi^*_{FC|FC} - L_0^{sym} = \max\{\Pi^*_{FC|FC} - L_0^{sym}, \Pi^*_{C|FC}\} \text{ for all } \mu \text{ and } q_0^F \tag{25}$$

[12] Horizontal differentiation μ is by definition between zero and infinity. However, our figures show only the range until $\mu = 1$ as the results do not change qualitatively for higher values of μ.

Assume in contrast that the licenser intends to establish market segmentation $\{FC, C\}$ as an equilibrium in stage 0.2 of the game. The licenser then sets its fee such that the firm offering FC does not want to deviate to offering C only; the fee equals the deviation profit of the firm offering FC given the other firm offers only C:

$$L_0^{seg} = \Pi^*_{FC|C} - \Pi^*_{C|C} \tag{26}$$

When the licenser sets this fee L_0^{seg}, the other firm could also start offering F, leading again to the symmetric head-to-head equilibrium, but we verifiy numerically that the potential entrant would always be worse off.[13] The license fee L_0^{seg} thus ensures that firms play the market segmentation equilibrium in stage 0.2 for all μ and q_0^F.

Summarizing, the licenser effectively chooses the equilibrium played in stage 0.2 by setting its fee. The licenser's preference between both outcomes depends both on (exogenous) horizontal differentiation μ and on (endogenous) vertical differentiation from label quality q_0^F. The licenser induces the product line equilibrium that gives him the highest profit Γ_0:

$$\Gamma_0 = \max\{2L_0^{sym}, L_0^{seg}\} \tag{27}$$

Numerically, we find that for strong market differentiation with $\mu > 0.48$, the licenser prefers the head-to-head equilibrium for all q_0^F; for weak market differentiation with $\mu < 0.43$, the licenser always prefers market segmentation. In the relatively small range between these values, the comparison depends on label quality q_0^F.

3.4 Label quality

The licenser profit Γ_0 depends on label quality q_0^F, and each product line equilibrium has different first-order conditions. Using the envelope theorem, we compute the licenser's first-order conditions for optimal label quality q_0^{F*}:

$$\frac{\partial \Gamma_0}{\partial q_0^F} = \begin{cases} \left[\frac{\partial \Pi_{i:FC|FC}}{\partial q_0^F} + \sum_s^{F,C} \frac{\partial \Pi_{i:FC|FC}}{\partial p_j^s}\frac{\partial p_j^s}{\partial q_0^F}\right] - \left[\frac{\partial \Pi_{i:C|FC}}{\partial q_0^F} + \sum_s^{F,C} \frac{\partial \Pi_{i:C|FC}}{\partial p_j^s}\frac{\partial p_j^s}{\partial q_0^F}\right] = 0 \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{if } \Gamma_0 = 2L_0^{sym} \\ \frac{\partial \Pi_{i:FC|C}}{\partial q_0^F} + \frac{\partial \Pi_{i:FC|C}}{\partial p_j^C}\frac{\partial p_j^C}{\partial q_0^F} = 0 \text{ if } \Gamma_0 = L_0^{seg}. \end{cases} \tag{28}$$

In the first line of equation (28), the licenser maximizes the deviation profit, that is the difference between the equilibrium played and the most profitable alternative, taking into account cross-price effects. The interests of licenser and industry are not aligned: a quality q_0^F that maximizes only the first element $\Pi^*_{FC|FC}$ would maximize joint licenser

[13] We always have $\Pi^*_{FC|FC} - \Pi^*_{C|FC} < \Pi^*_{FC|C} - \Pi^*_{C|C}$: offering F is always more profitable when the other firm does not offer F.

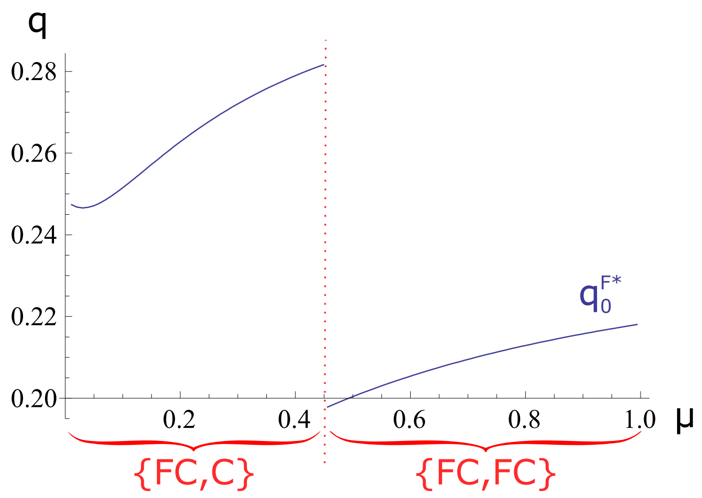

Figure 3: Equilibrium quality q_0^{F*} in stage 0.1 as a function of horizontal differentiation μ

and industry profits, while the licenser also wants to make the firm's best alternative (second bracket) less profitable by reducing quality q_0^F in equilibrium. In the second line of equation (28), the licenser maximizes its customer's profit.

The licenser has to trade off selling two cheaper licenses for its label versus selling one more expensive license. Let L_0^{sym*}, resp. L_0^{seg*}, denote the license fees with optimal quality q_0^{F*} maximizing the license fee in the head-to-head, resp. segmented, case. The licenser wants to play the symmetric head-to-head equilibrium $\{FC, FC\}$ if $2L_0^{sym*} > L_0^{seg*}$.[14] The trade-off crucially depends on horizontal differentiation μ: the higher μ, i.e. the lower the intensity of competition between the firms, the more profitable it is for a firm to offer a label that is also offered by the other firm; and higher surplus for the firm directly translates into higher license fees.

We numerically solve the first-order conditions of equation (28) for all values of horizontal differentiation μ, compare the resulting licenser profits for each equilibrium and find that there is a single threshold:

Proposition 1 $(2L_0^{sym*} - L_0^{seg*})$ *increases monotonically with horizontal differentiation* μ*: above* $\mu = 0.46$*, the licenser prefers symmetric head-to-head competition, selling two licenses; below this threshold, it prefers market segmentation, selling just one license.*

Figure 3 shows the optimal quality chosen by licenser F: for $\mu < 0.46$, it is more profitable for the licenser to set a high quality and a high fee, attracting only one firm in the market segmentation equilibrium. For $\mu > 0.46$, licenser F chooses a low quality and fee but sells its label to both firms, leading to the head-to-head equilibrium in stage 0.2. Within a

[14]This is related to, but not equal to the comparison $2\left[\Pi^*_{FC|FC} - \Pi^*_{C|FC}\right]$ versus $\left[\Pi^*_{FC|C} - \Pi^*_{C|C}\right]$, as the licenser sets different optimal qualities in each case.

given product line equilibrium, the optimal quality q_0^{F*} generally increases with horizontal differentiation μ (for $\mu > 0.05$).

3.5 Minimum quality requirement

In order to evaluate the scope for regulatory intervention, we define social welfare. As we compute the label quality given the duopoly's pricing game, these are second-best values. Following the example of organic certification, there is potentially scope for a government-imposed minimum quality requirement for fairtrade labels. As in organic certification, this standard would leave the conventional market unchanged but raise the label's quality to a regulated minimum level $\underline{q}$. We assume that the social planner cannot force labeling organizations to adjust downwards.

In nested logit models, expected consumer surplus S is the inclusive value of the highest nest level; here, it is thus the inclusive value at the decision level to buy the product or the outside good from equation (16). Social welfare W is the sum of the consumer surplus, the firms' profits and the licenser fee:

$$S = \gamma \ln \big(\exp(A^P/\gamma) + 1\big) \tag{29}$$

$$W = S + \sum_{j=1,2} \Pi_{j:y|z} \tag{30}$$

where $\Pi_{j:y|z}$ again denotes the profits of firm j when it plays y and the other firm plays z, with $y, z \in \{FC, C\}$.

We find that the social planner wants to maximize the number of available products. Thus, the social planner always wants both firms to offer F-labeled goods. However, for horizontal differentiation below $\mu < 0.46$ the social planner would have to *decrease* the label's quality to induce the head-to-head equilibrium, which he cannot do by assumption. For weak horizontal differentiation μ, the social planner sets the optimal quality for the segmented market constellation $\{FC, C\}$. As shown in Figure 4, the social planner always sets a minimum quality requirement above the equilibrium quality of licenser F.

4 Market entry of industry standard I

In the beginning of the second period $t = 1$, an industry standard I enters the market and announces its quality. The for-profit licenser F can then adjust its quality and license fee. Firms can now decide whether to offer one or both labels. This increases the number of possible market constellations, but we can again restrict the analysis to cases where each label is offered at least by one firm.

We assume that the for-profit licenser cannot undercut its quality q_0^{F*} from the previous period. This is motivated by the observed qualities of labels in the coffee market, where

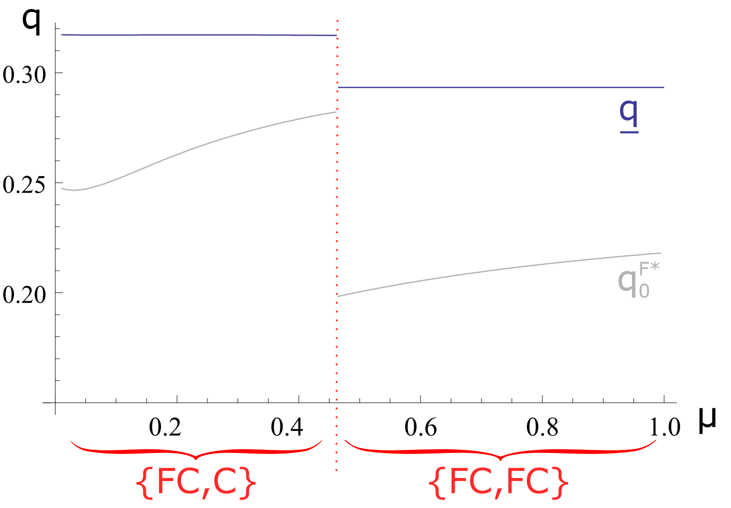

Figure 4: Minimum quality requirement $\underline{q}$ as a function of horizontal differentiation μ (unregulated equilibrium quality q_0^{F*} from stage 0.1 in gray)

the incumbent licenser has never adjusted downwards and new entrants have always established less stringent standards than the incumbent.

Our results show that the industry benefits from introducing an industry standard, because an additional good increases overall demand (less people opt for the outside good) and reduces the license fee. Moreover, for intermediate horizontal differentiation, one firm stops offering an F-labeled good, thereby reducing competition in that nest and payments to the licenser.

4.1 Consumer prices

We find that Lemma 1 can be generalized to a situation with two labeling organizations:

Lemma 2 *For all possible product line constellations, there are unique equilibrium prices p_i^s with $s = F, I, C$ and $i = 1, 2$ in stage 1.3; moreover*

(i) *when the product lines are symmetric (both firms offer the same qualities), prices are symmetric;*

(ii) *when firms compete head-to-head $\{FIC, FIC\}$ (both firms offer all qualities), prices are given by the marginal production costs $c(q^s)$ plus a constant and symmetric mark-up;*

(iii) *in partial market segmentation $\{FIC, IC\}$, the mark-up on the F-labeled product is higher than the mark-up on the I-labeled product and the difference in mark-ups decreases when the label qualities become more similar.*

Proof. See Appendix B on page 31. ■

With $y, z \in \{FIC, FC, IC, C\}$, we let $\Pi^*_{i:y|z}$ denote firm i's reduced profit with unique profit-maximizing prices when it plays y and the other firm plays z.

4.2 Product line decisions

Turning to stage 1.2 of the game and analyzing the firms' decision to offer one or both labels, we compute the firms' best responses to each other's product line. Assume firm 1 offers FIC. Then, firm 2's best response is given by

$$\max\left\{\Pi^*_{FIC|FIC} - L_1, \Pi^*_{FC|FIC} - L_1, \Pi^*_{IC|FIC}, \Pi^*_{C|FIC}\right\} \tag{31}$$

Solving the respective maximization problem for all other strategies of firm 1 and using symmetry allows us to fully characterize the equilibrium in stage 1.2 of the game. The equilibrium played in stage 1.2 of the game depends on μ, as well as on qualities q^I, q_1^F and fee L_1.

4.3 License fee

As in the first period, when deciding on its license fee L_1, the licenser has two options: it can aim to sell its label to both firms or it can decide to sell it to just one firm. In stage 1.1, this trade-off depends on μ as before and the quality q^I previously set by the Stackelberg leader industry standard I. The relevant cases are symmetric head-to-head competition $\{FIC, FIC\}$ and full market segmentation $\{FC, IC\}$, as before, plus additionally partial market segmentation $\{FIC, IC\}$. We also compute equilibrium qualities and prices for all other possible cases, but this section concentrates on the relevant cases, i.e. cases that are equilibria under certain conditions.

Assume first that the licenser aims at inducing the symmetric head-to-head equilibrium $\{FIC, FIC\}$, i.e. firms compete on all labels. In this case, the licenser sets its fee L_1 such that neither of the two firms offering FIC wants to deviate to offering IC only; the fee equals their deviation profit, given the other firm also offers FIC:

$$L_1^{sym} = \Pi^*_{FIC|FIC} - \Pi^*_{IC|FIC} \tag{32}$$

Numerically, we verify that firms indeed play the head-to-head equilibrium in stage 1.2 of the game when the licenser sets its fee at L_1^{sym}, as we have for all μ, q_1^F and q^I:

$$\Pi^*_{FIC|FIC} - L_1^{sym} = \max\left\{\Pi^*_{FIC|FIC} - L_1^{sym}, \Pi^*_{FC|FIC} - L_1^{sym}, \Pi^*_{IC|FIC}, \Pi^*_{C|FIC}\right\}$$

Secondly, assume that the licenser aims to establish partial segmentation – as we call the product line constellation $\{FIC, IC\}$ – as an equilibrium in stage 1.2 of the game. Then, the licenser sets its fee L_1 such that the firm offering FIC has no interest to deviate to offering IC; the fee equals the deviation profit of this firm, given the other firm offers IC:[15]

$$L_1^{pseg} = \Pi^*_{FIC|IC} - \Pi^*_{IC|IC} \tag{33}$$

Third, assume that the licenser aims to establish full market segmentation $\{FC, IC\}$ as an equilibrium in stage 1.2 of the game. The licenser sets its fee L_1 such that the firm offering FC has no interest in deviating to offer IC; the fee equals the deviation profit of this firm, given the other firm plays IC:

$$L_1^{seg} = \Pi^*_{FC|IC} - \Pi^*_{IC|IC} \tag{34}$$

The second element of L_1^{pseg} and L_1^{seg} is identical, so that the licenser's preference between full market segmentation and partial market segmentation is determined by the first element. If the licenser chooses the higher of these two fees with a license fee defined as $\max\{L_1^{pseg}, L_1^{seg}\}$, we numerically verify that both firms have no interest in deviating from the chosen constellation for all μ, q_1^F and q^I.[16] In both cases, the licenser sells just one license fee.

Summarizing this section, the licenser's profit Γ_1 can be written as:

$$\Gamma_1 = \max\{2L_1^{sym}, L_1^{pseg}, L_1^{seg}\} \tag{35}$$

4.4 Label quality of incumbent licenser F

As in the case with only one label (period $t = 0$), the optimal label quality q_1^{F*} maximizes the license fee. We assume that the incumbent for-profit licenser cannot decrease its quality below its monopoly value, q_0^{F*}, without seriously harming its brand image. For simplicity, we further assume that the licenser in the first period does not anticipate the entry of the industry standard in the second period. Using the envelope theorem, we can

[15] Theoretically, the possible alternative profits are $\Pi_{IC|IC}$ and $\Pi_{C|IC}$. However, we numerically have $\Pi_{IC|IC} > \Pi_{C|IC}$ for all q^I, q_1^F and μ.

[16] We numerically compute the equilibria for all L, μ, q_1^F and q^I: for many parameter constellations, the licenser cannot induce partial or full segmentation, but he can always induce the one that gives him the higher pay-off.

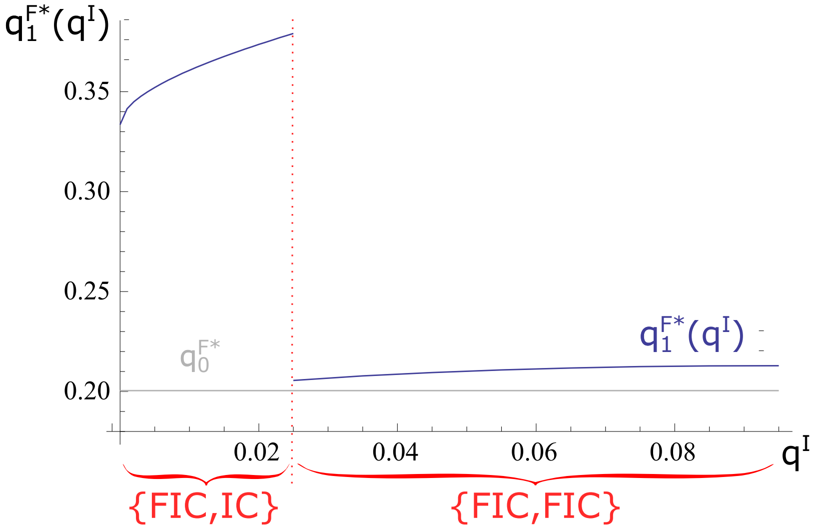

Figure 5: Reaction function of quality q_1^{F*} as a function of industry standard quality q^I for $\mu = 0.5$ (equilibrium quality q_0^{F*} from the previous period in gray)

again write down the corresponding first-order conditions:

$$\frac{\partial \Gamma_1}{\partial q_1^F} = \begin{cases} \left[\frac{\partial \Pi_{i:FIC|FIC}}{\partial q_1^F} + \sum_s^{F,I,C} \frac{\partial \Pi_{i:FIC|FIC}}{\partial p_j^s}\frac{\partial p_j^s}{\partial q_1^F}\right] - \left[\frac{\partial \Pi_{i:IC|FIC}}{\partial q_1^F} + \sum_s^{F,I,C} \frac{\partial \Pi_{i:IC|FIC}}{\partial p_j^s}\frac{\partial p_j^s}{\partial q_1^F}\right] = 0 \\ \hfill \text{if } \Gamma_1 = 2L_1^{sym} \\ \left[\frac{\partial \Pi_{i:FIC|IC}}{\partial q_1^F} + \frac{\partial \Pi_{i:FIC|IC}}{\partial p_j^I}\frac{\partial p_j^I}{\partial q_1^F} + \frac{\partial \Pi_{i:FIC|IC}}{\partial p_j^C}\frac{\partial p_j^C}{\partial q_1^F}\right] = 0 \text{ if } \Gamma_1 = L_1^{pseg} \\ \left[\frac{\partial \Pi_{i:FC|IC}}{\partial q_1^F} + \frac{\partial \Pi_{i:FC|IC}}{\partial p_j^I}\frac{\partial p_j^I}{\partial q_1^F} + \frac{\partial \Pi_{i:FC|IC}}{\partial p_j^C}\frac{\partial p_j^C}{\partial q_1^F}\right] = 0 \text{ if } \Gamma_1 = L_1^{seg} \end{cases} \tag{36}$$

In the first line of equation (36), the licenser sets its quality q_1^F combining the effect on the firm's profits against the effect on the firm's best alternative. Both $\Pi^*_{FIC|FIC}$ and $\Pi^*_{IC|FIC}$ increase in q_1^F as it increases the differentiation between nests F and I, and decrease in q^I as it decreases differentiation between nests F and I. The two qualities are strategic complements: the higher the quality q^I of the industry standard, the higher the optimal quality q_1^{F*} of the licenser, allowing him to set a higher fee L_1^{sym}. In the two latter cases of equation (36), there is no such strategic element and the licenser set its quality q_1^F maximizing the profits of the firm offering F.

As an example, Figure 5 plots the reaction function of the licenser quality q_1^{F*} to industry standard quality q^I for horizontal differentiation $\mu = 0.5$. For small q^I, the licenser induces partial market segmentation $\{FIC, IC\}$; for large q^I, the licenser induces head-to-head competition $\{FIC, FIC\}$. In the head-to-head equilibrium, the licenser distorts its quality downwards to increase its license fee by reducing the deviation profit, which explains the discontinuity in Figure 5. Within a product line equilibrium, q_1^{F*} is increasing in q^I.

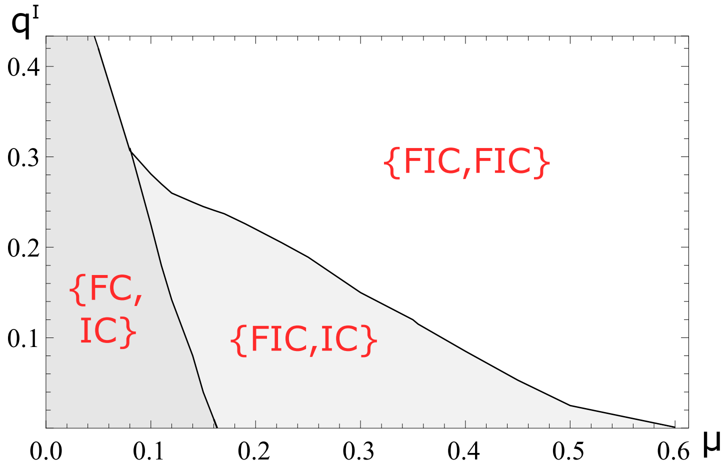

Figure 6: Preferred product range equilibrium of licenser F as a function of quality q^I and horizontal differentiation μ

Let L_1^{sym*}, resp. L_1^{seg*} and L_1^{pseg*}, denote the license fees with optimal quality, i.e. quality q_1^{F*} maximizing the license fee in the head-to-head, resp. fully and partially segmented, case. We numerically compute the optimal qualities for all μ and q^I and then compare $2L_1^{sym*}$, L_1^{pseg*}, and L_1^{seg*}. Figure 6 plots the resulting preferred product line of licenser F.

Proposition 2 *For strong horizontal differentiation $\mu > 0.61$, the licenser F induces head-to-head competition $\{FIC, FIC\}$ independently of industry standard quality q^I. For weak horizontal differentiation, $\mu < 0.05$, the licenser induces full market segmentation $\{FC, IC\}$. For intermediate values of μ, the product line equilibrium depends on industry standard quality q^I (Figure 6).*

Details on numerical calculations: See Appendix D on page 32. ■

The licenser prefers partial market segmentation over head-to-head competition if $L_1^{pseg*} > 2L_1^{sym*}$. Intuitively, low quality q^I decreases vertical competition between nests F and I, while low horizontal differentiation μ increases competition within nests. More in detail, lower horizontal differentiation μ increases the benefit of being the only firm offering an F-labeled good ($FIC|IC$ versus $IC|IC$) and increases the potential fee L_1^{pseg*}. At the same time, a lower μ decreases the mark-ups on the F-labeled product when both firms offer FIC ($FIC|FIC$ versus $IC|FIC$) and decreases the potential fee L_1^{sym*}.

The licenser prefers full market segmentation over partial market segmentation when $\Pi^*_{FIC|IC} < \Pi^*_{FC|IC}$. For low values of μ and q^I, the competition within nests is so strong that competing within a label market is not profitable: offering FC is better than offering FIC, given the other firm offers IC.

4.5 Label quality of new entrant I

In stage 1.0 of the second period, industry standard I sets its quality q^I, anticipating the equilibria in the following stages of the game, in particular the reaction of licenser F. The industry standard can influence the licenser by strategically setting its quality q^I. Proposition 2 and Figure 6 showed the levels of horizontal differentiation for which the industry standard can set its quality such that the licenser plays a segmentation equilibrium. We first compute the joint firm profit in the three cases mentioned before: head-to-head competition, partial segmentation, and full segmentation, subsequently comparing these three cases. Generally, firms want to segment the market as much as possible: the less product lines overlap, the higher joint firm profit.

The industry standard I maximizes joint profit of both firms. When the licenser induces head-to-head competition, we can use the expression for licenser fee L_1^{sym} from equation (32) to get an expression for joint firm profit:

$$\begin{aligned}\Pi^{sym} &= 2(\Pi^*_{FIC|FIC} - L_1^{sym}) \\ &= 2\Pi^*_{IC|FIC}\end{aligned} \tag{37}$$

In a partially segmented setting, where both firms offer an I-labeled good, but only one of them offers an F-labeled product, we can use the expression for licenser fee L_1^{pseg} from equation (33) to get an expression for joint firm profit:

$$\begin{aligned}\Pi^{pseg} &= (\Pi^*_{FIC|IC} - L_1^{pseg}) + \Pi^*_{IC|FIC} \\ &= \Pi^*_{IC|IC} + \Pi^*_{IC|FIC}\end{aligned} \tag{38}$$

For the full market segmentation equilibrium, we can use the expression for licenser fee L_1^{seg} from equation (34) to get an expression for joint firm profit:

$$\begin{aligned}\Pi^{seg} &= (\Pi^*_{FC|IC} - L_1^{seg}) + \Pi^*_{IC|FC} \\ &= \Pi^*_{IC|IC} + \Pi^*_{IC|FC}\end{aligned} \tag{39}$$

Comparing joint firm profits Π^{sym} and Π^{pseg}, the industry prefers partial market segmentation $\{FIC, IC\}$ over head-to-head competition if $\Pi^*_{IC|IC} > \Pi^*_{IC|FIC}$, i.e. if offering IC is more profitable when the other firm offers IC than if the other firm offers FIC. Numerically, this is almost always the case, because a firm offering FIC obtains a higher overall market share than a firm offering IC. Only for weak horizontal differentiation μ and exceptionally large vertical differentiation (low q^I and high q^F), the industry prefers head-to-head competition and this extreme region is never an equilibrium.

Comparing joint firm profits Π^{pseg} and Π^{seg}, the industry prefers full market segmentation over partial market segmentation if $\Pi^*_{IC|FC} > \Pi^*_{IC|FIC}$. Numerically, we verify that offering IC is always more profitable if the other firm offers FC than if the other firm offers FIC, because a firm benefits from being the only firm offering I-labeled goods. Firms thus always want to segment the market passing from $\{FIC, IC\}$ to $\{FC, IC\}$.

Let us summarize the comparisons between the relevant cases both for the licenser and the industry: the licenser wants to play the head-to-head equilibrium when μ and q^I are high; the partially segmented equilibrium when μ is intermediate and q^I is low; and the fully segmented equilibrium when μ and q^I are low (see Figure 6). The industry always wants market segmentation.

Combining this finding about the industry's preferred market outcome with the licenser's reaction in Figure 6 allows us to determine the equilibrium market constellations that are determined by the industry standard's quality q^I.

Proposition 3 *Depending on the degree of horizontal differentiation μ, the industry standard sets its quality q^{I*} following*

μ	*equilibrium*	q^{I*}	q_1^{F*}
> 0.61	*head-to-head* $\{FIC, FIC\}$	$\arg\max\{\Pi^{sym}\}$	$\arg\max\left\{L_1^{sym} \| q^{I*}\right\}$
$[0.16, 0.61]$	*partially segmented* $\{FIC, IC\}$	$\max\{q^I \| L_1^{pseg*} \geq 2L_1^{sym*}\}$	$\arg\max\left\{L_1^{pseg} \| q^{I*}\right\}$
$[0.13, 0.16]$	*fully segmented* $\{FC, IC\}$	$\max\{q^I \| L_1^{seg*} \geq L_1^{pseg*}\}$	$\arg\max\left\{L_1^{seg} \| q^{I*}\right\}$
$(0, 0.13]$	*fully segmented* $\{FC, IC\}$	$\arg\max\{\Pi^{seg}\}$	$\arg\max\left\{L_1^{seg} \| q^{I*}\right\}$

Details on numerical calculations: See Appendix D on page 33. ■

When horizontal differentiation is strong ($\mu > 0.61$), the industry standard maximizes its profit in the symmetric head-to-head constellation from equation (37) by setting quality q^I under following first-order condition:

$$\frac{\partial \Pi^{sym}}{\partial q^I} = \frac{\partial \Pi^*_{IC|FIC}}{\partial q^I} + \frac{\partial \Pi^*_{IC|FIC}}{\partial q_1^F}\frac{\partial q_1^F}{\partial q^I} = 0 \tag{40}$$

The industry standard I maximizes the firms' surplus from offering the label taking into account that a higher q^I also induces a higher q_1^F (see discussion in Subsection 4.4). This strategic effect increases q^I, relative to the solution maximizing only the direct effect on $\Pi^*_{IC|FIC}$.

If the industry standard can induce partial market segmentation $\{FIC, IC\}$ with a positive quality q^I (i.e. when horizontal differentiation μ is intermediate with $\mu \in [0.16, 0.61]$), then the industry prefers this outcome over head-to-head competition. For intermediate horizontal differentiation μ, the industry standard sets its quality low enough to make the licenser just indifferent between playing the head-to-head equilibrium $\{FIC, FIC\}$ and partial market segmentation $\{FIC, IC\}$:

$$q^{I*} = \max\{q^I | L_1^{pseg*} \geq 2L_1^{sym*}\} \tag{41}$$

Thus, the equilibrium quality q^{I*} is lower than the quality that solves the first-order condition $\partial\Pi^{pseg}/\partial q^I = 0$, but the gain of playing an equilibrium with fewer products is high enough to compensate for the distortion in quality q^I. Graphically, the quality q^{I*} in Figure 7 can be deduced from Figure 6, as it is on the border between the area inducing $\{FIC, FIC\}$ and the area inducing $\{FIC, IC\}$.
Similarly, if the industry standard can induce full market segmentation $\{FC, IC\}$ with a positive quality q^I (i.e. when horizontal differentiation μ is sufficiently small with $\mu \in [0.13, 0.16]$), then the industry prefers this outcome over partial market segmentation. The optimal quality q^{I*} makes the licenser just indifferent between $\{FIC, IC\}$ and $\{FC, IC\}$:

$$q^{I*} = \max\{q^I | L_1^{seg*} \geq L_1^{pseg*}\} \tag{42}$$

Again, the quality q^{I*} in Figure 7 is graphically on the border between the area inducing $\{FIC, IC\}$ and the area inducing $\{FC, IC\}$ in Figure 6.
For weak horizontal differentiation μ ($\mu \in (0, 0.13]$), the industry standard can play an interior solution to its first-order condition in the fully segmented constellation, maximizing profits from equation (39). Analogously to the head-to-head case, the first-order condition in case of full market segmentation is

$$\frac{\partial\Pi^{seg}}{\partial q^I} = \frac{\partial\Pi^*_{IC|IC}}{\partial q^I} + \frac{\partial\Pi^*_{IC|FC}}{\partial q^I} + \frac{\partial\Pi^*_{IC|FC}}{\partial q_1^F}\frac{\partial q_1^F}{\partial q^I} = 0 \tag{43}$$

Figure 7 represents the equilibrium quality q^{I*} for different values of μ, as detailed in Proposition 3. Comparing Proposition 3 with the results in the case with only one labeling organization in Proposition 1, we understand that the industry standard effectively reduces the offer of F-labeled products for horizontal differentiation $\mu \in [0.46, 0.61]$ (shaded area in Figure 7).

Proposition 4 *The industry benefits from introducing the industry standard I, because*

(i) offering another vertically differentiated product increases total demand;

(ii) for $\mu \in [0.46, 0.61]$, the introduction of the industry standard induces one firm to stop offering an F-labeled good, thereby reducing competition and payments to the licenser;

(iii) at any given horizontal differentiation μ, the introduction of the industry standard lowers the license fee.

Details on numerical calculations: See Appendix E on page 34. ■

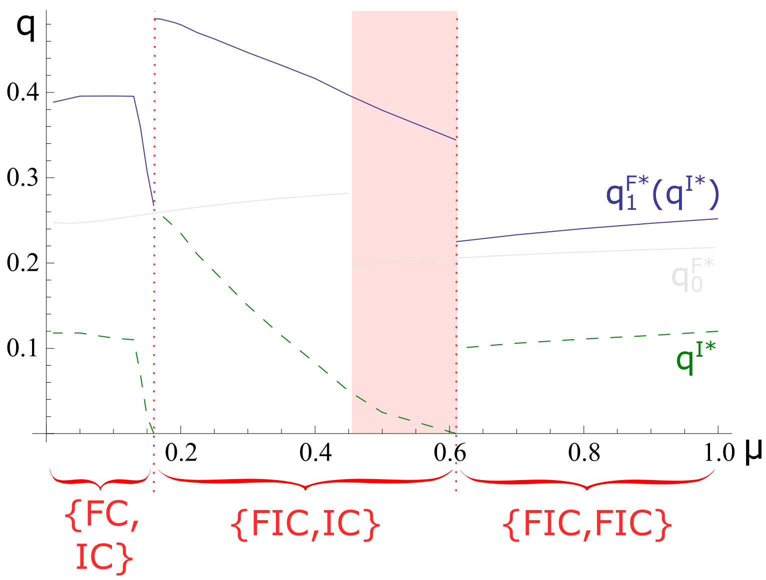

Figure 7: Equilibrium qualities q^{I*} and q_1^{F*} as a function of horizontal differentiation μ (q_0^{F*} from the previous period with one label in gray)

4.6 Minimum quality requirement

We use the same definitions of consumer surplus and social welfare as in equations (29) and (30). As before, we find that welfare increases in the number of products offered. The social planner wants to counteract the industry standard's effort to restrict product lines and reduce overlap. However, a minimum quality requirement is only binding for labels that are in equilibrium below this minimum standard $\underline{q}$. If the lower label is raised to the minimum standard, then the licenser strategically adjusts the higher label.

Table 1 shows how the social planner determines the optimal minimum standard $\underline{q}$. In the two polar cases – for very large and very small μ – where the industry standard plays an interior solution, the minimum quality $\underline{q}$ is not binding because the industry standard is already too high, leading to over-differentiation from the conventional market C relative to welfare optimizing values. In these markets, a minimum quality requirement cannot impact the status quo. A minimum quality requirement can only have a welfare-enhancing effect in the markets where the industry strategically distorts its quality to induce market segmentation. In these cases, the social planner solves the same equation as the industry standard, albeit the industry standard wants to be marginally below the solution inducing partial segmentation (resp. full segmentation) while the social planner wants to be marginally above inducing head-to-head product competition (resp. partial segmentation).

Table 1: Minimum quality requirement $\underline{q}$ set by the social planner as a function of horizontal differentiation μ

μ	equilibrium played	$\underline{q}$
> 0.61	head-to-head $\{FIC, FIC\}$	not binding
$[0.50, 0.61]$	head-to-head $\{FIC, FIC\}$	$\arg\max\{W^{sym}\}$
$[0.35, 0.50]$	head-to-head $\{FIC, FIC\}$	$\min\{q^I \mid L_1^{pseg*} \leq 2L_1^{sym*}\}$
$[0.14, 0.35]$	partially segmented $\{FIC, IC\}$	not binding
$[0.09, 0.14]$	partially segmented $\{FIC, IC\}$	$\min\{q^I \mid L_1^{seg*} \leq L_1^{pseg*}\}$
$[0.01, 0.09]$	fully segmented $\{FC, IC\}$	not binding

5 Conclusion

Our model describes the interaction between two firms and two labeling organizations of different quality; one of the labeling organizations is a for-profit licenser, the other one is an industry standard. We first model how a for-profit licenser sets its fee and quality when it is the only labeling organization on a market with two firms. We then allow for the entry of an industry standard and model the competition between two labels. In order to model sensible substitution patterns, we develop a discrete choice model with both horizontal differentiation (exogenously given) and vertical differentiation (from endogenous product quality) using a nested logit.

Our results show that the equilibrium product line depends on horizontal differentiation: the market is segmented if horizontal differentiation is weak, while firms are in head-to-head competition when horizontal differentiation is strong. In summary, firms seek vertical differentiation when horizontal differentiation is low.

We further find that the industry benefits from reducing overlap in the firms' product lines; against this background, the industry standard can serve as a coordination tool to induce market segmentation and increase profits. Interestingly, there are cases where firms play the fully segmented equilibrium where not all firms offer I-labeled goods, even though the industry standard charges no license fee.

Social welfare always benefits from head-to-head competition in our setting, reflecting a fundamental love of variety of consumers as well as a benefit from stronger competition. This leads to a conflict between industry and consumers, where the former want to reduce product lines such that they do not overlap and the latter want to maximize product diversity. A minimum standard set by the regulator can improve the situation in some cases. In other cases, however, the industry standard, set as an interior solution, is too high relative to the welfare-maximizing minimum standard: firms in duopoly benefit from differentiating more than the welfare-maximizing level.

Our results shed some light on product line decisions in complex markets like the one for coffee coffee: as we noted in the beginning, the product line equilibria in different national coffee markets are very different, with some featuring head-to-head competition (Germany) and others market segmentation (Finland), consistent with our theoretical analysis. Moreover, our model explains why the coffee industry collectively has an interest to introduce an industry standard. In practice, industry-related labels like UTZ and Rainforest Alliance have gained popularity in recent years. As the marginal production costs are lower, the global quantities of coffee sold under these industry-related labels are three times higher than the quantity sold under the Fairtrade label (Panhuysen and Pierrot, 2014). It remains an open question however, whether industry standards are strategically distorted downwards in order to decrease competition. Overall, there remains considerable scope for further research: for example, our model is limited to the strategic interactions within one country, whereas in practice labeling organizations set their license fees on a global scale for many heterogeneous countries.

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A Proof of lemma 1

In the symmetric head-to-head case $\{FC, FC\}$, profits are:

$$\Pi_{i:FC|FC} = D_i^F(p_i^F - q^F) + D_i^C p_i^C$$

Analyzing the first-order conditions, we find that there is a unique mark-up δ such that

$$p_i^{F*} = p_j^{F*} = p_i^{C*} + \delta = p_j^{C*} + \delta$$

with δ implicitly given by

$$\delta = 2\mu \left(1 - \frac{\mu}{\mu + \gamma \left[1 + (\exp(A^C/\mu^{F,C}) + \exp(A^F/\mu^{F,C}))^{\mu^{F,C}/\gamma}\right]}\right)$$

Simple calculations show that with $p^s = \delta + q^s$ the right hand side of the last equation is decreasing in δ, which establishes uniqueness. Furthermore, numerical calculations show that the second order conditions are satisfied at $p_i^s - q^s$. The same strategy applies for the symmetric equilibrium $\{C, C\}$.

In the asymmetric segmented case $\{FC, C\}$, firm i playing FC has the first-order conditions:

$$\frac{p_i^F - q^F}{p_i^C} = \frac{D_i^C \; \partial D_i^C / \partial p_i^F - D_i^F \; \partial D_i^C / \partial p_i^C}{D_i^F \; \partial D_i^F / \partial p_i^C - D_i^C \; \partial D_i^F / \partial p_i^F}$$

Substituting the demand functions and the respective derivatives leads to

$$\frac{p_i^F - q^F}{p_i^C} = 1 + \frac{(\mu^{F,C} - \mu) \exp\left(p_i^C/\mu\right)}{\mu \exp\left(A^C/\mu\right)}$$

The mark-up on the C-labeled good is identical to the mark-up on the F-labeled good when their qualities are equal, i.e. $\mu^{F,C} = \mu$. If the labels are vertically differentiated, then the mark-up on the F-labeled product is higher, as this is the market where the firm offering FC is in monopoly.

Furthermore, differentiating both sides of the equation with respect to p_i^F shows that the left-hand side is increasing in p_i^F while the right-hand side is decreasing in p_i^F. Additionally, using the solution of this equation numerical calculations show that

$$\frac{\partial \Pi_{i:FC|C}}{\partial p_i^C} = (p_i^F - q^F)\frac{\partial D_i^F}{\partial p_i^C} + D_i^C + p_i^C \frac{\partial D_i^C}{\partial p_i^C} = 0$$

has exactly one solution in p_i^C.

Applying the same procedure for firm j we obtain

$$\frac{\partial \Pi_{j:C|FC}}{\partial p_j^C} = D_j^C + p_j^C \frac{\partial D_j^C}{\partial p_j^C} = 0$$

has exactly one solution in p_j^C.

B Proof of lemma 2

In the symmetric head-to-head case $\{FIC, FIC\}$, profits are:

$$\Pi_{i:FIC|FIC} = D_i^F(p_i^F - q^F) + D_i^I(p_i^I - q^I) + D_i^C p_i^C$$

Analyzing the corresponding first-order conditions, we find again, as in Lemma 1 that there is a unique mark-up δ:

$$p^{s*} - q^s = \delta \text{ with } \delta \text{ implicitly given by}$$
$$\delta = 2\mu \left(1 - \frac{\mu}{\mu + \gamma \left[1 + (\exp(A^C/\mu^{FI,C}) + \exp(A^{FI}/\mu^{FI,C}))^{\mu^{FI,C}/\gamma} \right]} \right)$$

Simple calculations show that with $p^s = \delta + q^s$ the right hand side of the last equation is decreasing in δ, which establishes uniqueness. Furthermore, numerical calculations show that the second order conditions are satisfied at $p_i^s - q^s$. As mentioned in the proof of lemma **1**, an analogous result holds for $\{FC, FC\}$ and $\{C, C\}$.
In the $\{FC, IC\}$ case, firm i playing FC has the first-order conditions:

$$\frac{p_i^F - q^F}{p_i^C} = \frac{D_i^C \; \partial D_i^C / \partial p_i^F - D_i^F \; \partial D_i^C / \partial p_i^C}{D_i^F \; \partial D_i^F / \partial p_i^C - D_i^C \; \partial D_i^F / \partial p_i^F}$$

Substituting the demand functions and the respective derivatives leads to

$$\frac{p_i^F - q^F}{p_i^C} = \Psi \frac{\mu \exp\left(p_j^C/\mu\right) + \mu^{FI,C} \exp\left(p_i^C/\mu\right)}{\mu^{F,I} \exp\left[\left(v^F - p_i^F\right)/\mu^{F,I}\right] + \mu^{FI,C} \exp\left[\left(v^I - p_j^I\right)/\mu^{F,I}\right]}$$
$$\text{with} : \Psi = \frac{\mu^{F,I} \exp(A^{FI}/\mu^{F,I})}{\mu \exp(A^C/\mu)}$$

Furthermore, differentiating both sides of the equation with respect to p_i^F shows that the left-hand side is increasing in p_i^F while the right-hand side is decreasing in p_i^F. Additionally, using the solution of this equation numerical calculations show that

$$\frac{\partial \Pi_{i:FC|IC}}{\partial p_i^C} = (p_i^F - q^F)\frac{\partial D_i^F}{\partial p_i^C} + D_i^C + p_i^C \frac{\partial D_i^C}{\partial p_i^C} = 0$$

has exactly one solution in p_i^C. Applying the same procedure for firm j we obtain

$$\frac{p_j^I - q^I}{p_j^C} = \Psi \frac{\mu \exp\left(p_i^C/\mu\right) + \mu^{FI,C} \exp\left(p_j^C/\mu\right)}{\mu^{F,I} \exp\left[\left(v^I - p_j^I\right)/\mu^{FI,C}\right] + \mu^{FI,C} \exp\left[\left(v^F - p_i^F\right)/\mu^{F,I}\right]}$$

Again, while the left-hand side is increasing in p_j^I, the right-hand side is decreasing in p_j^C and

$$\frac{\partial \Pi_{j:IC|FC}}{\partial p_j^C} = (p_j^I - q^I)\frac{\partial D_j^I}{\partial p_j^C} + D_j^C + p_j^C \frac{\partial D_j^C}{\partial p_j^C} = 0$$

has exactly one solution in p_j^C.

In the $\{FIC, IC\}$ case, we also compute the first-order conditions for the firm i playing FIC. Substituting the demand functions and the respective derivatives leads to

$$\frac{p_i^F - q^F}{p_i^I - q^I} = 1 + \frac{(\mu^{FI,C} - \mu)\exp\left(p_i^I/\mu\right)}{\mu \exp(A^I/\mu)}$$

If the labels are vertically differentiated, then the mark-up on the F-labeled product is higher, as this is the market where the firm offering FIC is in monopoly.

The proof for uniqueness of equilibrium prices works identically to the previously shown full market segmentation $\{FC, IC\}$ case.

C Calculations for Proposition 2

For determining the equilibrium in stage 1.1 where the licenser sets its fee and quality, we numerically compute for each value of industry standard q^I the optimal licenser quality q^{F*} for each of the three fees L^{sym}, L^{pseg} and L^{seg}. We then compare the reduced licenser profit with optimal quality $2L^{sym*}$, L^{pseg*} and L^{seg*} and keep the case that maximizes licenser profits. This gives us the reaction function of the licenser $q_1^{F*}(q^I)$ shown in Figure 5.

As an illustration, Figure 8 plots the license fee as a function of label quality q_1^F for horizontal differentiation $\mu = 0.4$. At this level of horizontal differentiation, the licenser chooses the highest fee between L_1^{sym} and L_1^{pseg}. Moreover, it cannot undercut the label quality from the previous period with only one label q_0^{F*} drawn as a gray line. For $q^I = 0.07$, the maximum is such that the licenser chooses the partially segmented market constellation. When q^I increases, the symmetric equilibrium becomes more attractive and the distance between the maxima of the two curves explains the jump on Figure 5.

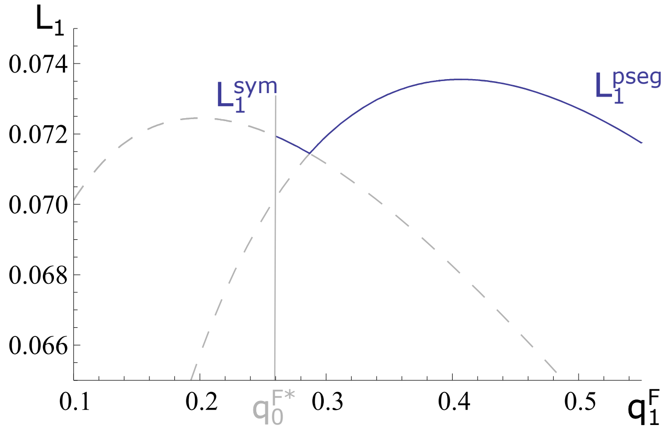


Figure 8: License fee as a function of label quality q_1^F for $\mu = 0.4$ (with $q_0^{F*} = 0.28$) and $q^I = 0.07$

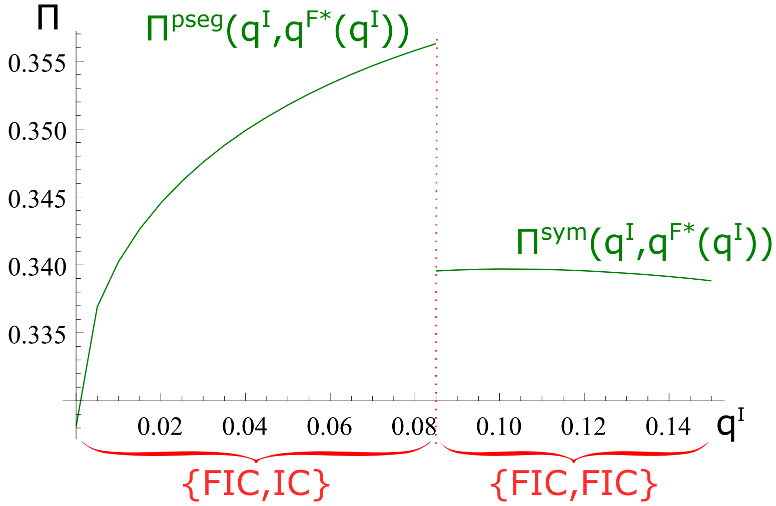


Figure 9: Joint firm profit Π as a function of industry standard q^I given licenser reaction $q_1^{F*}(q^I)$ for $\mu = 0.4$

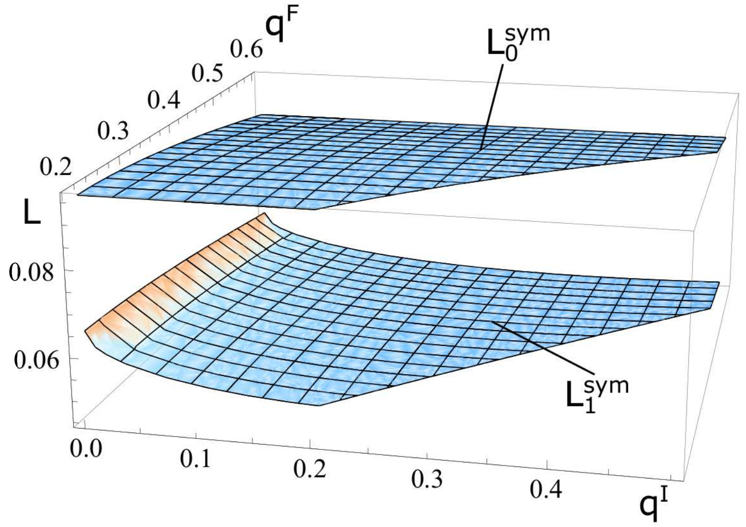
D Calculations for Proposition 3

In order to determine the equilibrium in stage 1.0 where the industry decides on its standard, we first compute the licenser reaction in q_1^F and L_1 for each level of horizontal differentiation μ and each industry standard q^I. We then determine for each horizontal differentiation μ, the q^{I*} that maximizes joint firm profit Π.

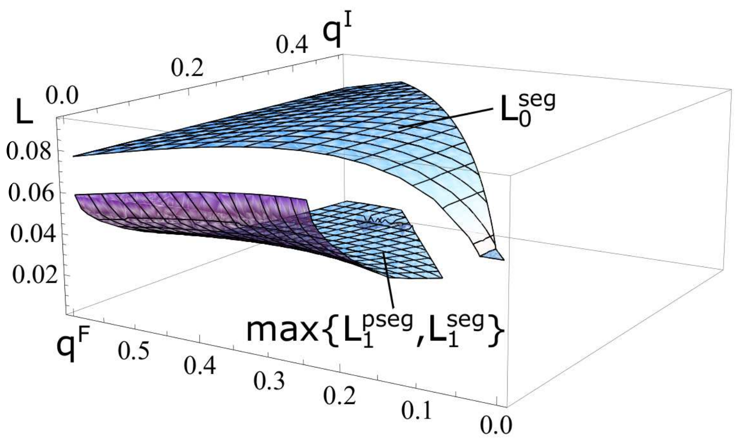
As an example, Figure 9 shows the joint firm profit Π for different values of industry standard q^I, holding horizontal differentiation μ fixed at 0.4. There is a jump in the curve, because the licenser F switches from partial segmentation to head-to-head competition when q^I increases above 0.085. The joint firm profit is maximized by the corner solution ensuring partial segmentation.

E Calculations for Proposition 4.(iii)

Figure 10 shows that the license fees are systematically lower upon entry of the industry standard. In the first graphic, with $\mu = 0.6$, we compare head-to-head competition license fees L_0^{sym} and L_1^{sym} for different values of licenser quality q^F and industry standard q^I; L_1^{sym} is always smaller. In the second graphic, with $\mu = 0.1$, we compare segmented (resp. partially segmented) market license fees L_0^{seg} and $\max\{L_1^{pseg}, L_1^{seg}\}$ for different values of licenser quality q^F and industry standard q^I; $\max\{L_1^{pseg}, L_1^{seg}\}$ is always smaller.



(a) License fee for head-to-head competition for possible values of q^I and q_t^F with $\mu = 0.6$



(b) License fee for segmented equilibria for possible values of q^I and q_t^F with $\mu = 0.1$

Figure 10: Comparing license fees from $t = 0$ and $t = 1$